

**WE CLAIM:**

1. A method for chemical analysis of drilling-, drill-in, completion-, formation-, and production fluids , which may be employed at rig site or in a remote location, comprising:
  - a) Collecting samples of fluids from predetermined fluid collection points where the drilling-, drill-in-, completion-, formation-, or production fluid are flowing or stored ;
  - b) Introducing said samples into a microfluidic system for chemical measurement containing at least one microfluidic device characterized by at least one microfluidic channel and at least three reservoirs, optionally said microfluidic device operably connected to a computing device;
  - c) Executing one or more selected tests on said microfluidic device;
  - d) Providing a means of detecting results of the tests and generating data;
  - e) Translating said data to provide results of said analytical test; and
  - f) Monitoring said results to adjust selected aspects of the drilling, completion, and production operations.
2. The method of Claim 1 (a) further comprising the samples are collected from a position selected from flow lines to the well, flow lines from the well, bottom hole assembly near the drill bit, under the cuttings shakers, and at a dedicated production line sample station.
3. The method of Claim 1 further comprising fluids are transported on the microfluidic device by a method selected from electro-kinetic forces (i.e. applying an electric

field), by applying a pressure gradient across the channels, or by use of micro-electric pumps.

4. The method of Claim 3 further comprising pressure, vacuum, voltage, or currents can be applied at all ports on the chip, in various combinations to provide maximum flexibility for the movement, addition, mixing, dilution and separation of fluids.

5. The method of Claim 4 further comprising a computer software program is used to control flow rates, dilutions, and measurements.

6. The method of Claim 1(c) further comprising the selected test utilizes fluorescence method.

7. The method of Claim 6 further comprising:

- a) Generating a standard curve using a standard solution that contains a known concentration of the sample;
- b) Adding a suitable fluorescent dye to the standard solution;
- c) Measuring quenching or increase of dye's intensity using standard fluorescence detection methods, incorporating the use of photomultiplier tubes, and generating a curve;
- d) Comparing said generated standard and sample curves; and
- e) Determining the concentration of the sample.

8. The method of Claim 7 further comprising employing bandwidth filters that optimize excitation and emission spectra.

9. The method of Claim 7(e) wherein the concentration is determined by a method selected from visual comparison of the standard curve to the sample curve or by using automated evaluation of the concentration.

10. The method of Claim 7 wherein all steps are incorporated in a computer program.

11. The method of Claim 7 further comprising the selected tests selected from a test to measure shale reactivity and zeta potential.
12. The method of Claim 11 wherein the dye is selected from styryl dyes, oxanols, carbocyanines, and rhodamine.
13. The method of Claim 7 further comprising the selected test measures high ion concentration.
14. The method of Claim 13 wherein the dye is an affinity indicator for high ion concentrations.
15. The method of Claim 7 further comprising the selected test measures amine-type shale inhibitors and enzymes.
16. The method of Claim 15 further comprising the dye is a protein specific dye capable of binding amines.
17. The method of Claim 7 further comprising the selected test measures the presence of biopolymers.
18. The method of Claim 17 further comprising the dye detects biopolymers by reacting them with species specific enzymes and detecting glucose.
19. The method of Claim 7 further comprising the selected test measures the presence of oxygen scavengers using a dye for measuring reactive oxygen species.
20. The method of Claim 7 further comprising the selected test detects crude oil and emulsions using lipid sensitive dyes.
21. The method of Claim 7 further comprising the selected test measures water in invert mud systems using flow-tracing dyes. (fluorescein)
22. The method of Claim 7 further comprising the selected test measures trace elements selected from sulfur, nickel, and vanadium.

23. The method of Claim 7 further comprising the selected test measures water hardness as a function of total calcium and magnesium.
24. The method of Claim 23 further comprising the test utilizes fluorescent  $\text{Ca}^{+2}$  indicators.
25. The method of Claim 7 further comprising the selected test measures bromide ion by conversion to hypobromite.
26. The method of Claim 7 further comprising the selected test measures heavy metals (Zn, Ba, Cd).
27. The method of Claim 26 further comprising the test utilizes a dye selected from a fluorescent transition metal indicator, a zinc chelator, and heavy metal indicator.
28. The method of Claim 7 further comprising the selected test measures chloride concentrations.
29. The method of Claim 28 further comprising the test utilizes Acridine Orange.
30. The method of Claim 7 further comprising the selected test measures sodium and potassium.
31. The method of Claim 7 further comprising the selected test detects/measures sulfide.
32. The method of Claim 7 further comprising the selected test detects/measures sulfides compounds.
33. The method of Claim 7 further comprising the selected test is an assay for phosphates.
34. The method of Claim 7 further comprising the selected test detects microbes.
35. The method of Claim 7 further comprising the selected test determines the efficiency of biocides by detecting live and dead cells by staining.

36. The method of Claim 7 further comprising the selected test measures iron content.
37. The method of Claim 1 c further comprising the selected test measures compatibilities of completion acids and brines with crude oil by measuring relative flow changes in microfluidic channels.
38. The method of Claim 1 c further comprising the selected test measures compatibilities of formation brine with completion fluid by measuring relative flow changes in microfluidic channels.
39. The method of Claim 1 c further comprising the selected test measures hydrocarbon species by liquid chromatography.
40. The method of Claim 1 wherein the selected test is measurement of resistivity.
41. The method of Claim 40 further comprising:
- a) Exciting said sample with a current;
  - b) Plotting current as a function of equivalent concentration for sample at a given current; and
  - c) Calculating the molar concentration of the fluid using the following:  
$$\text{Voltage} = \text{Resistance} \times \text{Current}$$
$$\text{Resistance} = \frac{\text{Specific Electrical Resistance} \times \text{length}}{\text{Cross Sectional Area}}$$
42. The method of Claim 41 wherein the current is in the range of 100 to 400 volts.
43. The method of Claim 42 further comprising resistivity is used to measure hydrate inhibitors.
- 44 The method of Claim 43 wherein the hydrate inhibitor is selected from ethylene glycol and methanol.

45. The method of Claim 1 further comprising the microfluidic system is incorporated in a benchtop instrument at rig site.
46. The method of Claim 45 further comprising the benchtop instrument incorporates broad-spectrum lamps (not used for biological systems since UV light kills cells.)
46. The method of Claim 46 wherein the broad-spectrum lamp is selected from mercury or argon.